AOS Applications Seminar: Understanding Data Needs in the Aviation Community

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May 26, 2022
1-2pm EST

FAA Inflight Icing Research

Uses of satellite data

Presented to: NASA AOS Applications Seminar

By: Danny Sims

Date: 26 May 2022

FAA Mission and Goal

- **Provide a safe and efficient national airspace for all aviation users**
- **Inflight Icing (IFI) is a safety issue, primarily for General Aviation but not exclusively**
- **FAA Inflight Icing Goal: enhance automated diagnosis and forecast to increase safety**

IFI Impact

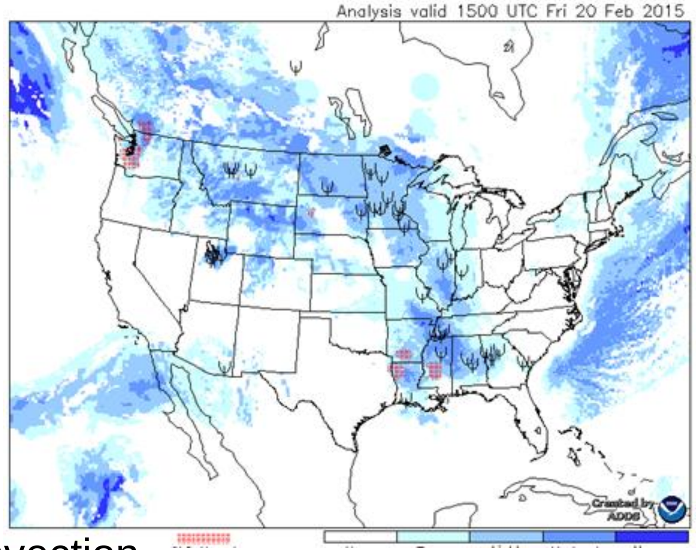
- National Transportation Safety Board (NTSB) 2008 – 2018 data shows at least 49 aircraft accidents with 58 fatalities with structural inflight icing as a cause or factor. Most are GA.
- Several other cases still under investigation and could increase the number.

Nonfatal accident involving inflight icing

Remnants of a fatal accident

IFI Diagnostic Product

- **Current Icing Product (CIP)**
  - Integrates multiple observations and numerical weather prediction output
  - Forms 3-d diagnosis of the inflight icing environment
    - Satellite looking down (cloud/no-cloud)
    - METAR looking up along with precipitation type
    - Radar looking slant-wise; lightning denoting convection
    - NWP background and filling the gaps
    - In situ PIREPS



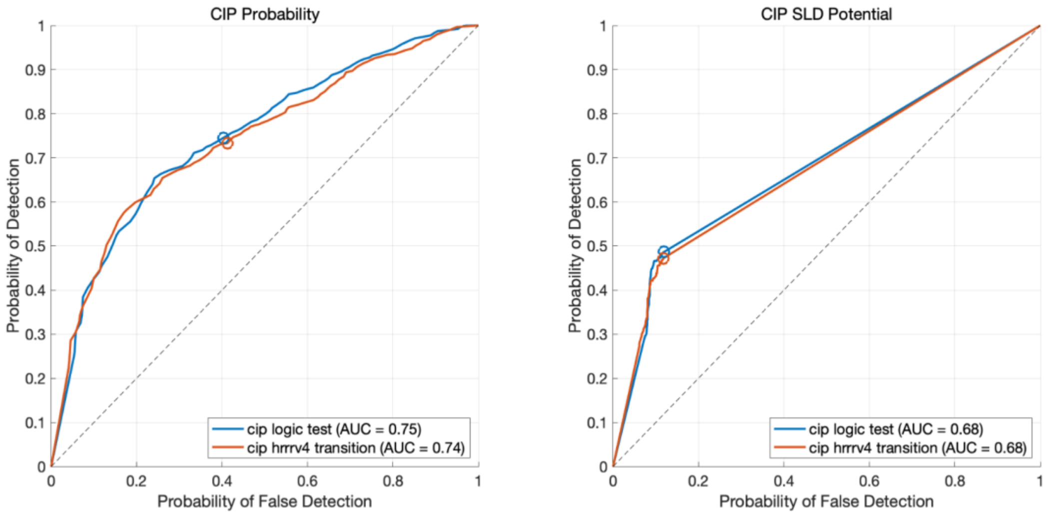
Satellite Upgrades

- **GOES-16 and 17**
  - Moved from National Lightning Detection Network to Geostationary Lightning Mapper
  - Additional information using ABI channels 2, 5, and 6
    - Ch 5 used to infer cloud top phase (reflectance generally higher for liquid than ice); combined with model or cloud top temperature to infer supercooled liquid tops
    - Difference of Ch 2-6 used to infer presence of supercooled large drops (difference is sensitive to phase and size) with ice having highest values, followed by large liquid drops, and lastly by small liquid drops
    - Product of Ch 5 * (2-6) used to isolate large liquid drops
    - Used in the topmost cloud layer

Performance

- Used In-Cloud ICing and Large-drop Experiment (ICICLE) field campaign data
- Bulk comparisons (blue is with upgrades)

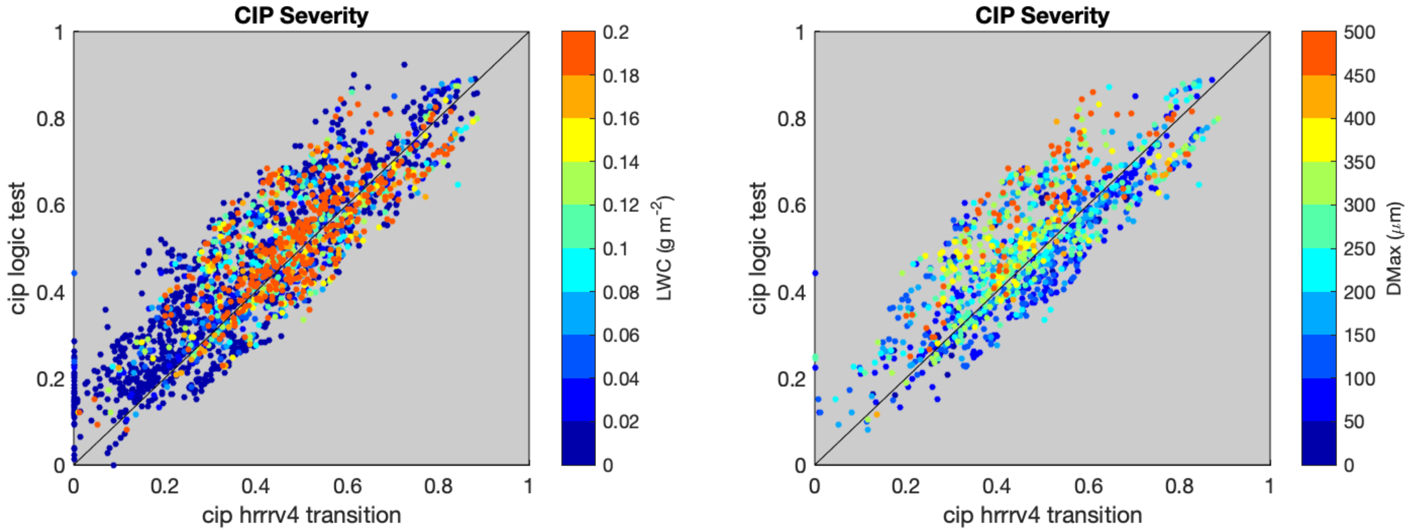
Figures courtesy of NCAR



Performance

- **Icing Severity comparisons (upgrades on y-axis)**

Figures courtesy of NCAR



- **Case study showed improvement in areas of FZDZ, but degradation in small drop and glaciated conditions**

Use of Polar Orbiting Satellites

- Icing Product Alaska (IPA) 2018 study
- Blending of polar and geostationary due to lack of geostationary across northern regions
- Used NOAA-15, 18, and 19 due to data availability and similarity of wavelengths
- Different weighting schemes showed little differences when both datasets available
- Problems with data availability led to only using GOES-17 in experimental version

Other Uses

- Have used GPM, CALIPSO for quality assessments as an independent data source
- Biggest challenge is operational availability of data
- AOS could be very beneficial for inflight icing, turbulence, convective weather

References

- Adriaansen, D., 2018: Results of IPA Evaluation Process. FAA Deliverable 2.
- Rugg, A., D. Adriaansen, and J. Haggerty, 2022: Report on Use of GOES-16 and -17 to Identify Areas of Potential Inflight Icing. FAA Deliverable 2.1.
- Rugg, A., D. Adriaansen, and J. Haggerty, 2022: Report on CIP performance using GOES-16 and -17 enhancements based upon Task 2 findings. FAA Deliverable 3.3.

Contact Information

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The Aviation Weather Center

Presentation for the AOS Applications Seminar on May 26, 2022

Ty Higginbotham

Cooperative Institute for Research in the Atmosphere (CIRA) and NWS Aviation Weather Center (AWC)

Aviation Weather Center

www.aviationweather.gov

OUR MISSION STATEMENT

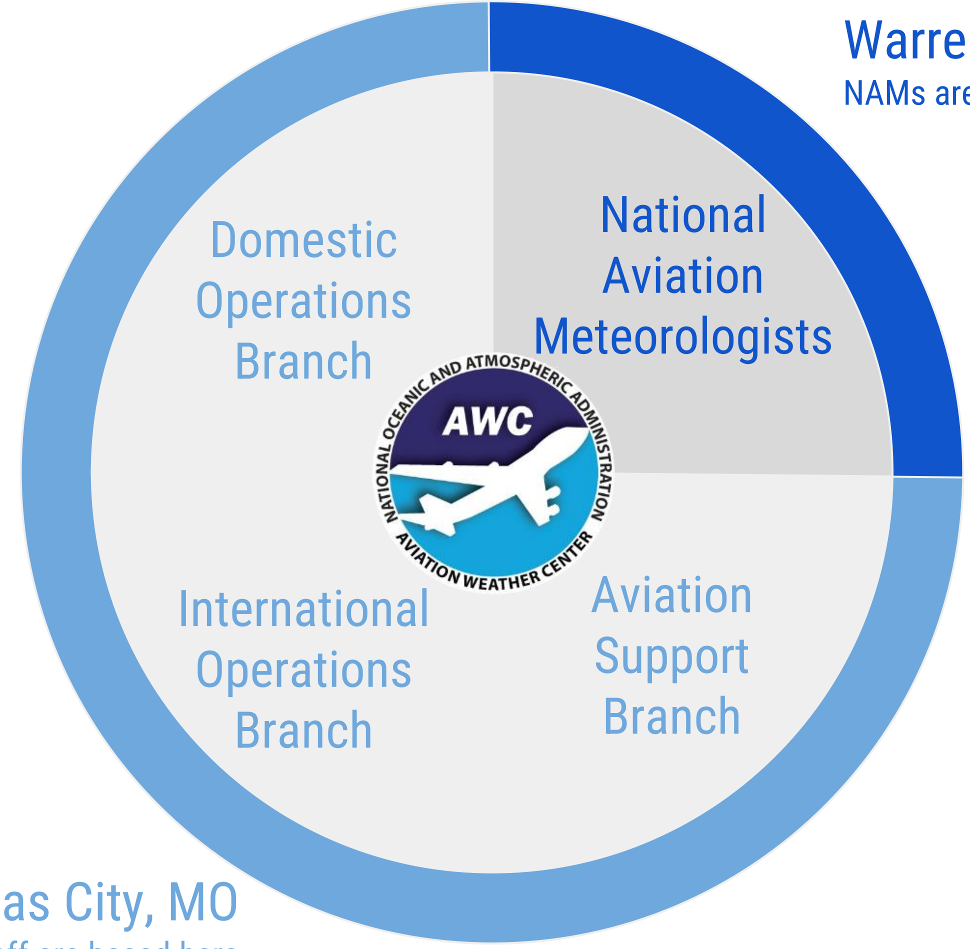
The Aviation Weather Center delivers consistent, timely and accurate weather information for the world airspace system. We are a team of highly skilled people dedicated to working with customers and partners to enhance safe and efficient flight.

OUR VISION

To be the trusted authority and leading innovator for aviation weather information.

Warrenton, VA

NAMs are embedded with the FAA at the ATCSCC

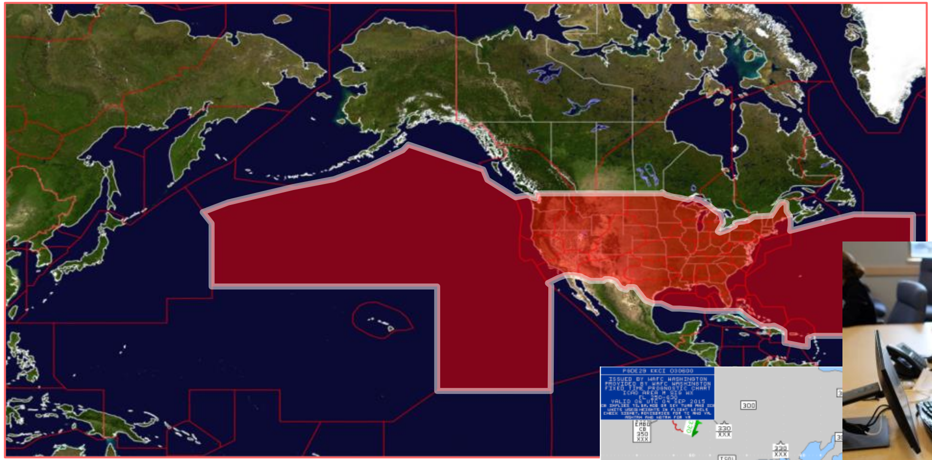


Kansas City, MO

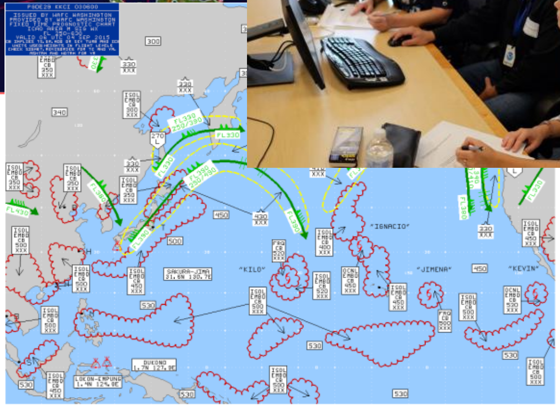
Most AWC staff are based here

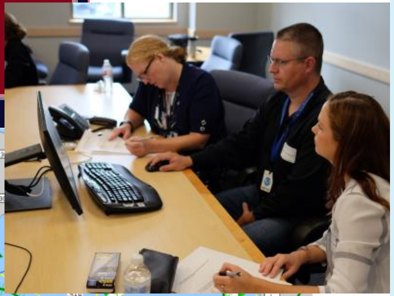
- 4 branches
- 2 locations (MO & VA)
- ~80 people
  - Forecasters
  - Researchers/developers
  - IT staff
  - Administrative support staff
  - Managers & supervisors
  - NOAA Corps Officer

Aviation Weather Center



One of the nine NWS national centers

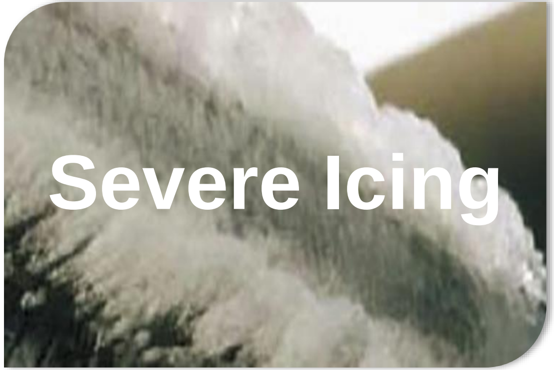


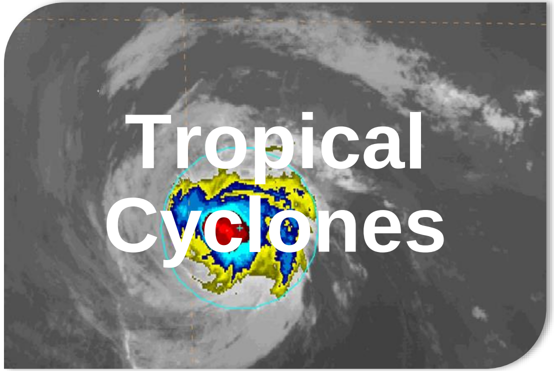


Domestic and international aviation forecasts and warnings

AviationWeather.gov

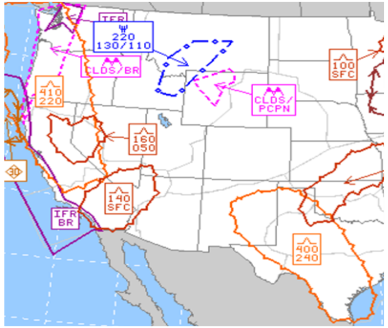
Aviation Warnings

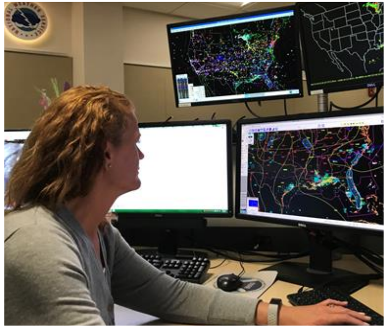




Aviation Weather Center Operations

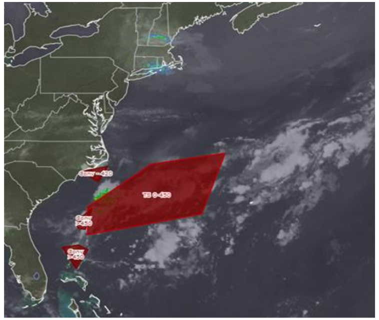
Domestic Operations

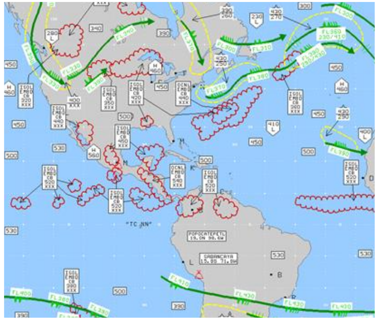


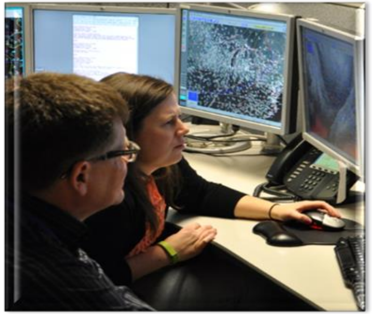


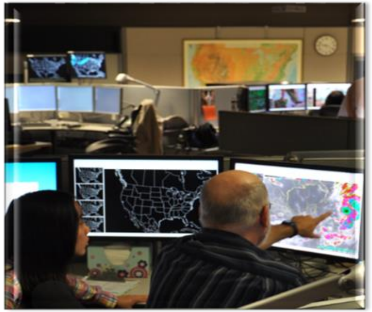
AVIATION WARNINGS	AVIATION FORECASTS	COLLABORATION	DESKS
CONUS · coastal waters	AIRMETs · TFM convective forecast · Low-level SIGWX	CWSUs · Airlines · FAA	Convective SIGMET · TCF · Turbulence · Icing · Clouds & visibility
Atlantic · Pacific	Global Significant Weather (SIGWX) · Area Forecasts for Gulf of Mexico & Caribbean	International meteorological services	Tropical · SIGWX North · SIGWX South

International Operations









Aviation Weather Center Support Branch

PRODUCTS & SERVICES	DATA, TECHNOLOGY, & INFRASTRUCTURE	SCIENCE & TECHNOLOGY
Graphical Forecasts for Aviation (GFA) · WAFS Internet File Service (WIFS) · Computer models · Operational shift fill-in	IT architecture & security · Production systems · Data management · Support for remote forecast operations	Aviation Weather Testbed (AWT) · Aviation Weather Research Program · Research initiatives

Use of Remote Sensing for Turbulence

- Remote sensing (water vapor imagery) allows AWC forecasters to see the relationship between spatial features on satellites and corresponding results in near real-time.
- Low and mid-level water vapor imagery is used to visualize turbulence within the atmosphere.
- Visible imagery is used to visualize static stability.
- Remote sensing is key over the Intermountain West and the Rockies to identify cloud structure features to understand the significance of turbulence.
- High res mesoscale imagery detect the location of gravity waves from MCS.
- Detects mountain and gravity waves.
- Utilize a product called bypass filtering. Allows AWC to separate the atmosphere into different layers to identify turbulence within different layers of the atmosphere.
    - High pass filters are used to visualize turbulence within the upper levels of the atmosphere.
    - Compare it with NWP output to understand if correlations exist between atmospheric features and turbulence.
- Use a combination of thermal soundings (RAP), water vapor imagery (Ch 8, 9, and 10), and visible imagery to identify transverse banding, layers of potential static stability, and increased shear to identify potential áreas of turbulence.
- Water vapor imagery (Ch 8, 9, and 10) are used to identify áreas of stretching, convergence, and location of merging jet features that are favorable for turbulence development.

Use of Remote Sensing for Icing

- Icing forecasts are developed from familiar remote sensing products.
- Use radar technology to understand icing potential.
- Use several different satellite RGB composite imagery tables to analyze the potential for supercooled liquid water droplets.
- Use RGBs to determine cloud layers, which could lead to icing potential.
- Combine RGBs and surface observations to determine the location of cold low-level stratus deck. However, this is time consuming.
- Primarily use surface observations, METARs, and PIREPs for icing potential

Other Topics

- Remote sensing barrier
  - Size of the data. When working remotely, it can be a challenge to display all satellite data needed for the job. Usually have to thin the data temporally.
- Working with Tony Wimmers and Scott Lindstrom of CIMSS to improve satellite based turbulence guidance in AWIPS.
- Radar echo tops and cloud top heights are very important, especially for AWC’s convective products.
- MODIS/VIIRS
  - AWC used to look at MODIS icing products, but feed wasn’t particularly reliable.
  - AWC kind of uses VIIRS. Use it in mosaics to look at polar regions.
    - Some VIIRS based RGBs AWC made available in N-AWIPS.

Thank you!